

Cofactors for the acquisition of HIV-1 among heterosexual men: prospective cohort study of trucking company workers in Kenya

Joel Rakwar, Ludo Lavreys*, Mary Lou Thompson[†], Denis Jackson*, Job Bwayo, Salim Hassanali[‡], Kishorchandra Mandaliya[‡], Jeckoniah Ndinya-Achola and Joan Kreiss[§]

Objective: To determine the prevalence, incidence, and correlates of HIV-1 infection in a cohort of east African trucking company employees.

Methods: HIV-1-seronegative trucking company employees were enrolled in a prospective cohort study and evaluated at 3 monthly intervals for HIV-1 seroconversion, sexually transmitted diseases, and sexual behavior.

Results: The baseline seroprevalence of HIV-1 among 1500 trucking company employees was 17.8%. Among 752 HIV-1-seronegative men who were followed, the HIV-1 annual seroincidence was 3.1%. In univariate analysis, HIV-1 acquisition was associated with age under 25 years, 10 years or less of sexual activity, occupation as a driver/driver's assistant, occupational travel for more than 14 days per month, religion other than Christian or Muslim, uncircumcised status, sex with a prostitute, sex with a girlfriend/casual partner, extramarital sex, and enrollment seropositivity to *Treponema pallidum*, *Haemophilus ducreyi*, and Herpes simplex virus type 2 (all *P* values ≤ 0.05). Using multivariate analysis, HIV-1 acquisition was independently associated with 10 years or less of sexual activity (hazard rate ratio (HRR) 2.0, 95% confidence interval (CI) 1.0–4.3), occupation as a driver/driver's assistant (HRR 3.9, 95% CI 1.7–9.0), religion other than Christian or Muslim (HRR 6.1, 95% CI 1.4–25.7), uncircumcised status (HRR 2.3, 95% CI 1.0–5.0), and unprotected sex with a prostitute (HRR 2.8, 95% CI 1.1–7.0).

Conclusions: Trucking company employees had a high HIV-1 seroprevalence rate at enrollment and a high HIV-1 seroincidence during follow-up. Risk factors for HIV-1 seroconversion included years of sexual activity, occupation, religion, uncircumcised status, and unprotected sex with a prostitute. This population is an appropriate target for HIV-1 prevention trials and behavioral interventions.

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AIDS 1999, **13**:607–614

Keywords: circumcision, heterosexual transmission, HIV-1, sexually transmitted diseases

Introduction

The spread of HIV-1 in sub-Saharan Africa has been rapid and devastating [1]. The predominant mode of

spread of HIV-1 in the region is heterosexual contact, which accounts for approximately 80% of infections [2]. Part of the rapid spread has been attributed to the geographical mobility of truck drivers, who have been

From the Department of Medical Microbiology, University of Nairobi, Nairobi, Kenya; Departments of *Epidemiology, [†]Biostatistics, and [§]Medicine, University of Washington, Seattle, WA, USA; [‡]Coast Provincial General Hospital, Mombasa, Kenya.

Sponsorship: This work was supported by grants from the National Institutes of Health A1-33873 and T22-TW00001 and through Family Health International (FHI/NO1-A1-35173-119).

Requests for reprints to: Joan Kreiss, MD, MSPH, Box 359909, University of Washington, Seattle, WA 98195, USA.

Date of receipt: 17 June 1998; revised: 6 November 1998; accepted: 5 January 1999.

identified as a male occupational group at high risk of sexually transmitted disease (STD) and HIV-1 acquisition [3–5].

Several cross-sectional studies of the sexual behavior of truck drivers in Africa and Asia have been published [3,4,6–8]. The HIV-1 seroprevalence in those studies varied from as low as 1–2% among Indian or Thai truck drivers [7,8] to as high as 26–35% among east African truck drivers [3,4,6]. Most of the truck drivers in the studies reported a history of sex with multiple partners, and history of sex with a prostitute was common [3,4,7,8]. Factors associated with HIV-1 seropositivity among these men included frequency of sex with a prostitute, history of genital ulcer disease, urethral discharge, positive syphilis serology, higher monthly income, higher education status, and uncircumcised status [3,4,6]. None of the studies were prospective in design, and there have been few prospective cohort studies of HIV-1 acquisition among heterosexual men conducted in Africa or indeed any part of the world [9–11].

In 1993, a prospective cohort study of HIV-1 seronegative trucking company employees in Mombasa, Kenya, was initiated to characterize HIV-1 sero-incidence and risk factors, with the long-term goal of establishing a cohort for HIV-1 prevention trials. In this study, we evaluate cofactors associated with HIV-1 seroconversion within this cohort of men.

Methods

Study participants and procedures

A prospective cohort study was started in March 1993 in Mombasa, Kenya as part of the Preparation for AIDS Vaccine Evaluation/HIV Network for Prevention Trials (PAVE/HIVNET) program, as previously described [12,13]. Briefly, the research team, comprising a physician, nurse, health educator, and clerk, visited the site of each of six participating trucking companies once a week. All male trucking company employees, except those who were employed as casual workers, were invited to attend the mobile research clinic. After informed consent was obtained, HIV-1 pre-test counselling was performed and 10 ml of blood was obtained for testing for antibodies to HIV-1 and *Treponema pallidum*. In addition, the sera from sub-samples of HIV-1 seronegative men were tested for antibodies to *Haemophilus ducreyi*, *Chlamydia trachomatis*, and herpes simplex virus type 2 (HSV-2).

The men were advised to return after 1 week for laboratory results, syphilis treatment if indicated, and HIV-1 confidential post-test counselling, at which time they were enrolled into the prospective cohort study if

they were HIV-1 seronegative. At enrollment, a standardized questionnaire was administered regarding demographic, occupational, sexual, and medical history, and a physical examination was conducted, including the determination of circumcision status. Men with STD signs or symptoms underwent further evaluation. If a urethral discharge was present, a urethral swab sample was taken for Gram stain and culture for *Neisseria gonorrhoeae* and antigen detection for *C. trachomatis*. Empiric treatment with amoxicillin, probenecid, clavulanic acid, and doxycycline was administered. Men with genital ulcers were evaluated for the presence of *H. ducreyi* by culture and for syphilis by serology. Men with genital ulcers were treated with erythromycin. Syphilis was treated with benzathine penicillin. The health educator held informal group discussions regarding HIV-1, STDs, and risk reduction at each site. Condom promotion was included in these sessions and free condoms were provided.

The enrolled men were asked to return every 3 months for follow-up visits. An appointment list was generated for each clinic day, allowing the identification of those workers who were due for follow-up. The project clerk attempted to trace men who failed to come to clinic within the company grounds, but no attempts were made to trace men to their homes because of concerns about confidentiality and the need to respect privacy. At follow-up, a questionnaire was administered regarding sexual behavior, STD symptoms, and symptoms of acute HIV-1 infection during the preceding 3 months. A physical examination was performed, and samples obtained for STD diagnosis where indicated. Ten milliliters of blood for HIV-1 serology was obtained at each of these visits. Serological testing for *T. pallidum* was repeated at yearly intervals. At each visit, men received free treatment for STDs and minor medical conditions, a supply of condoms, and a refreshment. No other incentives were provided. Participants who were found to be HIV-1 seropositive received appropriate counselling and continued to be followed in the research clinic. HIV-1 serological test results were maintained in confidential fashion by the research team.

The study was approved by ethical review committees at the University of Nairobi and the University of Washington.

Laboratory procedures

Antibodies to HIV-1 were tested using serial enzyme-linked immunosorbent assays (ELISAs; Enzygnost, Behring, Marburg, Germany and Recombigen, Cambridge Biotech Corp., Worcester, MA, USA). A Western blot assay (Cambridge Biotech Corp.) was performed to confirm all HIV-1 seroconversions and to evaluate all ELISA discordant samples. Testing for syphilis included the rapid plasma reagin card test

(RPR; Becton–Dickinson, Cockeysville, MD, USA) and *T. pallidum* hemagglutination assay (TPHA; Becton–Dickinson). A positive RPR and TPHA defined active syphilis. Antibodies to *H. ducreyi* were detected by lipooligosaccharide ELISA, as described by Alfa *et al.* [14], using purified lipooligosaccharide obtained from the *H. ducreyi* strains HD524 and HD034. Testing for antibodies to HSV-2 was done using Western blot. HSV-2 antibodies were distinguished from HSV-1 using densitometric analyses [15]. Antibodies to *C. trachomatis* were detected using a microimmunofluorescence test [16]. Gonorrhoea was defined by a positive culture on modified Thayer–Martin medium. Non-gonococcal urethritis was defined by the presence of five or more polymorphonuclear cells per high power field of a Gram-stained slide of urethral secretions or the detection of antigen to *C. trachomatis* using enzyme immunoassay (Microtrak Chlamydia Immunoassay, Syva, San Jose, CA, USA), in the absence of *N. gonorrhoeae* infection. Genital ulcers were cultured for *H. ducreyi* on activated charcoal medium.

Statistical methods

All data were collected using standardized forms and were double-entered using Statistical Package for the Social Sciences for Windows, version 6.0 software (SPSS, Chicago, IL, USA). The data were analysed using SPSS and S-Plus (MathSoft Inc., Seattle, WA, USA) software. Pearson's χ^2 test and Fisher's exact test were used to compare categorical variables. Hazard ratios for HIV-1 seroconversion were estimated using Cox univariate and multivariate regression models. STD and sexual behavior risk factors that changed over time during follow-up were analysed in these models as time-dependent covariates. Risk factors that had *P* values of less than 0.1 were considered for inclusion in the multivariate analysis. The proportional hazards assumption underlying the multivariate model was assessed using Harrell's *z*-test and the fit of the model was also examined by plots of the Schoenfeld and standardized score residuals [17].

Results

Between March 1993 and June 1997, 1500 men were screened for antibodies to HIV-1, of whom 267 (17.8%) were seropositive. Of the 1233 HIV-1-seronegative men, 999 (81%) returned for their results. Of these, seven (0.7%) declined further participation. A total of 992 HIV-1-seronegative men were thus enrolled into the prospective cohort study. Eighty-nine per cent of the enrollments occurred during the first 2 years of the study. Of the enrolled men, 755 (76%) returned for at least one follow-up visit by June 1997. Men who did and did not return for follow-up were

similar with regard to median age (29 versus 29 years), unmarried status (37 versus 39%), median age at first sex (15 versus 15 years), history of sex with a female commercial sex worker (56 versus 53%), history of condom use (54 versus 52%), and number of sex partners in the previous year (two versus two). Drivers and driver's assistants were more likely to be lost to follow-up than other occupational groups (32 versus 20%, *P* < 0.0005).

Of the 755 men who returned for follow-up, three were excluded because an HIV-1 serological result was not available at any visit after enrollment. The analysis therefore included 752 men. The mean number of follow-up visits was 5.3 (range 1–18), for a total of 4001 follow-up clinic visits. The mean time between visits was 4.4 months (range < 1–42). The median duration of follow-up was 20 months (range 1–51). One thousand four hundred and fifty-six person years of follow-up were thus accrued. Compliance with follow-up in this group was 69% at 1 year, 52% at 2 years, and 38% at 3 years. We believe that there were two main reasons for poor compliance with follow-up. First, drivers and their assistants were often at the company base in Mombasa for only a short time between trips. The research clinic was held at each company only one morning a week, so drivers and their assistants often missed their appointments. Second, there was a high rate of turnover in the work force, particularly among unskilled employees, and this was accentuated during a period of economic recession in Kenya that occurred while our study was in progress.

Table 1 summarizes the enrollment characteristics of the 752 men who were included in the final analysis. Half of the men were under 30 years of age and two-thirds were married. Forty-three per cent of the cohort reported occupational travel away from Mombasa, with one-fifth being away for more than half the time. Only half of the men in the cohort reported a history of condom use, including 60% of Catholic and Muslim men. A history of sex with a female commercial sex worker was reported by half of the men, with drivers and their assistants more likely to report this practice than other worker categories (79 versus 46%, *P* < 0.0005). Muslims were less likely than other religious groups to have a history of sex with a prostitute (48 versus 58%, *P* = 0.03). The rate of circumcision in this cohort was 87%. Ten per cent of the men had an STD or STD syndrome (urethral discharge, genital ulcer disease, or syphilis) at their enrollment examination. Of 41 men with urethral discharge, 11 (41%) of 27 tested had *N. gonorrhoeae* on culture and one (7.7%) of 13 tested had *C. trachomatis* antigen detected. Of 11 men with genital ulcers, *H. ducreyi* was isolated from four (44%) of nine from whom cultures were obtained. Serological evidence of past STDs was common, with a positive TPHA in 8%,

Table 1. Enrollment characteristics of the men in the cohort

	Median (range) or proportion (%) (n = 752)	
Demographic		
Age	29	(16–62)
Marital status		
Single/divorced/widowed	282	(37%)
Currently married	470	(63%)
Religion		
Protestant	298	(40%)
Catholic	252	(33%)
Muslim	160	(21%)
Other	42	(6%)
Years of education	9	(0–16)
Consumes alcohol	349	(46%)
Occupational		
Years as an employee	4	(< 1–38)
Occupation		
Driver	84	(11%)
Driver's assistant	149	(20%)
Mechanic	227	(30%)
Other	292	(39%)
Travel		
None	430	(57%)
Travel ≤ 14 days per month	161	(21%)
Travel > 14 days per month	161	(21%)
Sexual		
Age at first sex	15	(9–30)
Years of sexual activity	13	(0–45)
Ever used a condom	405	(54%)
History of prostitute sex	423	(56%)
Prostitute sex past year	236	(31%)
Unprotected prostitute sex past year	145	(19%)
More than one sex partner past year	436	(58%)
Uncircumcised	95	(13%)
STD serology and examination findings		
Urethral discharge on examination	41	(5%)
Genital ulcer on examination	11	(1%)
RPR and TPHA-positive	30/654	(5%)
TPHA-positive	59/743	(8%)
<i>H. ducreyi</i> antibody-positive	103/413	(25%)
<i>C. trachomatis</i> antibody-positive	46/119	(39%)
HSV-2 antibody-positive	54/116	(47%)

HSV-2, herpes simplex virus type 2; RPR, rapid plasma reagin card test; TPHA, *T. pallidum* hemagglutination assay.

H. ducreyi antibodies in 25%, *C. trachomatis* antibodies in 39%, and HSV-2 antibodies in 47%.

Table 2 presents reported sexual behavioral characteristics during follow-up. Despite risk reduction counselling, 25% of men reported one or more episodes of sex with a prostitute, most of which was unprotected with condoms. Over two-thirds of men reported extramarital sex and only 77 (15%) of these men reported consistent use of condoms with extramarital sex partners.

Consistent with this high-risk sexual behavior, STDs were commonly diagnosed during follow-up, with some men having multiple occurrences (Table 3). The incidence of genital ulcers observed on physical examination was 4.1 per 100 person years (py). The incidence of urethral discharge observed on physical examination was 15.6 per 100 py, and its etiology was

Table 2. Sexual behavioral characteristics of the men during follow-up

Behavioral characteristic	Median (range) or number (%)	
During 3 months before visit		
Number of sex partners	1	(0–30)
Frequency of:		
sex acts	12	(0–126)
sex acts with wife	9	(0–75)
unprotected sex acts with wife	9	(0–75)
sex acts with girlfriend/casual partner	1	(0–90)
unprotected sex acts with girlfriend/casual partner	0	(0–49)
sex acts with prostitute	0	(0–29)
unprotected sex acts with prostitute	0	(0–29)
extramarital sex acts	1	(0–90)
unprotected extramarital sex acts	0	(0–49)
During the course of follow-up		
Sex with wife	575	(76%)
Unprotected sex with wife	571	(76%)
Sex with girlfriend/casual partner	480	(64%)
Unprotected sex with girlfriend/casual partner	411	(55%)
Sex with prostitute	186	(25%)
Unprotected sex with prostitute	131	(17%)
Any extramarital sex	515	(69%)
Any unprotected extramarital sex	438	(58%)

evenly distributed between gonorrhoea and non-gonococcal urethritis. An additional 50 episodes of genital ulcers and 128 episodes of urethral discharge were self-reported by men as having occurred between clinic visits. The combined incidence was thus 7.6 per 100 py for genital ulcer disease and 24.3 per 100 py for urethral discharge. A total of 177 men (24%) had observed genital ulcer or urethral discharge or both during the course of follow-up, and an additional 54 (7%) had self-reported symptoms.

During 1456 py of follow-up, 45 men seroconverted to HIV-1, giving an annualized seroconversion of 3.1%. Enrollment factors associated with seroconversion included age under 25 years, 10 years or less of sexual activity, occupation as a driver/driver's assistant, more than 14 days per month of occupational travel, religion other than Christian or Muslim, and uncircumcised status (Table 4). Evidence of previous high-risk sexual behavior (e.g. a history of sex with prostitutes and

Table 3. Incidence of sexually transmitted diseases during follow-up

	Number of cases	Incidence/100 py*
Genital ulcers (observed)	60	4.1
<i>H. ducreyi</i> culture-positive	10	0.7
Syphilis [†]	4	0.3
Urethral discharge (observed)	227	15.6
<i>N. gonorrhoeae</i> culture-positive	108	7.5
<i>C. trachomatis</i> ELISA-positive	16	1.1
Non-gonococcal urethritis	119	8.2
Genital warts	19	1.3

*Person years. [†]Fourfold increase in rapid plasma reagin (RPR) titer and *T. pallidum* hemagglutination assay (TPHA) positive.

Table 4. Univariate analysis of covariates of HIV-1 seroconversion

Covariate	Hazard rate ratio	95% confidence interval	P-value
Enrollment characteristics			
Age < 25	1.9	(1.0–3.6)	0.03
Age at first sex	1.0	(0.9–1.1)	0.5
Years of sexual activity ≤ 10	2.2	(1.2–4.0)	0.009
Married	1.0	(0.6–1.9)	0.9
Occupation			
Driver	2.6	(1.1–6.4)	0.03
Driver's assistant	2.9	(1.3–6.1)	0.005
Mechanic	0.6	(0.2–1.5)	0.2
Other	1.0	–	–
Occupational travel			
> 14 days per month	2.8	(1.5–5.4)	0.002
≤ 14 days per month	1.0	(0.4–2.3)	1.0
None	1.0	–	–
Religion			
Protestant	2.7	(0.9–7.9)	0.07
Catholic	2.4	(0.8–7.4)	0.1
Other	6.0	(1.6–23.0)	0.008
Muslim	1.0	–	–
Consumes alcohol	1.5	(0.8–2.6)	0.2
History of condom use	2.3	(1.2–4.5)	0.01
History of prostitute sex	1.9	(1.0–3.5)	0.05
Uncircumcised	2.4	(1.1–4.5)	0.02
TPHA-positive	2.7	(1.3–5.9)	0.01
<i>H. ducreyi</i> antibody-positive	2.0	(1.0–3.9)	0.05
HSV-2 antibody-positive	2.9	(1.2–7.0)	0.02
<i>C. trachomatis</i> antibody-positive	0.8	(0.3–1.9)	0.6
During the follow-up period*			
Sex with wife	0.9	(0.5–1.6)	0.6
Unprotected sex with wife	0.8	(0.4–1.5)	0.5
Sex with girlfriend/casual partner	1.9	(1.0–3.4)	0.03
Unprotected sex with girlfriend/casual partner	1.7	(0.9–3.1)	0.1
Sex with prostitute	3.1	(1.5–6.5)	0.002
Unprotected sex with prostitute	3.8	(1.7–8.6)	0.001
Extramarital sex	2.4	(1.3–4.5)	0.004
Unprotected extramarital sex	2.1	(1.1–3.8)	0.02
Genital ulcer [†]	2.7	(0.8–8.8)	0.1
Urethral discharge [†]	2.2	(0.9–5.3)	0.07

*The following variables were analysed as time-dependent covariates. [†]Includes both observed and self-reported episodes. HSV-2, herpes simplex virus type 2; TPHA, *T. pallidum* hemagglutination assay.

seropositivity to *T. pallidum*, *H. ducreyi*, and HSV-2) was also associated with HIV-1 acquisition. No sex with men or intravenous drug use was reported.

During follow-up, sex with any extramarital partner, whether girlfriend/casual partner or prostitute, was associated with HIV-1 acquisition. The magnitude of the association was highest for sex with a prostitute

unprotected by a condom. Men with STD were at increased risk of HIV-1 infection, albeit not significantly so. In univariate analysis, genital ulcer was associated with a 2.7-fold increased risk of HIV-1 (95% CI 0.8–8.8) and urethral discharge was associated with a 2.2-fold increased risk (95% CI 0.9–5.3). Both genital ulcer and urethral discharge were significantly associated with occupational travel and extramarital sex

Table 5. Multivariate analysis of covariates for HIV-1 seroconversion

Variable	Hazard rate ratio	95% confidence interval	P-value
Age < 25	1.0	(0.4–2.2)	1.0
Years of sexual activity ≤ 10	2.1	(1.0–4.3)	0.05
Driver/driver's assistant	3.9	(1.7–9.0)	0.002
Occupational travel > 14 days per month	1.3	(0.6–2.8)	0.5
Religion			
Christian	2.0	(0.7–5.8)	0.2
Other religion	6.1	(1.4–25.7)	0.01
Muslim	1.0	–	–
Uncircumcised	2.3	(1.0–5.0)	0.05
Unprotected girlfriend/casual partner sex*	1.6	(0.9–2.9)	0.1
Unprotected prostitute sex*	2.8	(1.1–7.0)	0.03
Genital ulcer* [†]	1.4	(0.5–4.2)	0.5
Urethral discharge* [†]	0.6	(0.2–1.9)	0.4

*These variables were analysed as time-dependent covariates. [†]Includes both observed and self-reported episodes.

(including sex with girlfriend/casual partner, sex with a prostitute, and multiple sex partners) (data not shown).

Many of the risk factors for HIV-1 acquisition identified in univariate analysis were interrelated. To assess their independent contributions to the risk of HIV-1 acquisition while controlling for potential confounding, the variables were evaluated in a multivariate Cox regression model (Table 5). Ten years or less of sexual activity, occupation as a driver/driver's assistant, religion other than Christian or Muslim, uncircumcised status, and unprotected prostitute sex were independently associated with HIV-1 acquisition. After controlling for other factors, the HRR was 1.4 for the association between genital ulcer and HIV-1 seroconversion (95% CI 0.5–4.2) and 0.6 (95% CI 0.2–1.9) for urethral discharge.

Discussion

In this large prospective cohort study of trucking company workers, a baseline HIV-1 seroprevalence of 17.8% and an annual HIV-1 seroincidence of 3.1% were documented, confirming that this represents a high-risk occupational group. Two interrelated occupational factors, employment as a driver/driver's assistant and duration of time on the road, were both risk factors for HIV-1 seroconversion. Drivers or driver's assistants had a fourfold increased risk of acquiring HIV-1 compared with mechanics and ancillary workers. The former were more likely than the latter to report occupational travel of more than 2 weeks per month, leading to greater absence from their homes and families. In addition, these men have the highest incomes among trucking company employees and may be better able to afford to pay for sexual encounters. Both factors probably contributed to the higher frequency of prostitute contact reported by this group.

Most men in the cohort reported high-risk sexual encounters at enrollment, with 56% reporting a history of sex with a prostitute, including 31% reporting prostitute contact during the previous year, two-thirds of which was unprotected by condoms. During follow-up, 25% of men reported sex with a prostitute. The high prevalence of HIV-1 and other STDs among prostitutes in Kenya has been well documented [18,19]. It is therefore not surprising that unprotected sex with a female commercial sex worker was associated with a 2.8-fold increased risk of HIV-1 seroconversion in multivariate analysis. We have previously reported that there was a reduction in the number of high-risk sexual encounters over time among the men in this cohort, in response to a behavioral intervention program, but no change in condom use [13]. The challenge of effecting

sexual behavioral change in trucking company workers is highlighted by the high HIV-1 seroincidence in this cohort.

Condom promotion and marketing have been carried out extensively and aggressively in both the print and electronic media in Kenya. Despite this, only 15% of the men reported the consistent use of condoms with extramarital partners. This risk-taking sexual behavior is occurring in a society where 40% of respondents in a national survey reported personal knowledge of someone with AIDS [20]. A similar dissociation between knowledge and practice was found among Indian truckers, of whom 56% were aware of HIV-1, yet 68% failed to use condoms with female commercial sex workers [8]. In a related study in our cohort, we found that 86% of respondents to a vaccine acceptability questionnaire acknowledged the personal risk of HIV-1 infection [21]. Behavioral research in developing countries is needed for a better understanding of the determinants of sexual behavior, including the reasons for high-risk encounters despite a personal perception of risk.

There was a high prevalence of antibodies to both ulcerative and non-ulcerative STDs at enrollment, indicative of past high-risk exposures. During the course of the study, 31% of men had an STD syndrome. High incidence rates of genital ulcer and urethral discharge were documented, with the latter occurring three to four times more frequently than the former. There was a trend towards an association between both STD syndromes and HIV-1 seroconversion in univariate analysis, but the magnitude of the association dropped markedly after controlling for sexual exposure and circumcision status. The lack of a significant association between the occurrence of genital ulcer disease and HIV-1 acquisition in univariate analysis may well be because of insufficient power. The decreased magnitude and significance of the association between STDs and HIV-1 acquisition in multivariate analysis suggests that the effect of STDs is potentially confounded by other cofactors included in the model.

Men with 10 years or less of sexual activity at the time of study enrollment had a twofold increased risk of HIV-1 acquisition compared with men who had over 10 years experience. This could reflect differing patterns of unprotected sexual encounters not measured in this study. We speculate that those men with over 10 years of sexual experience have formed sexual networks with others who had encountered the HIV-1 epidemic earlier, and if infected, had infection for a longer average duration, whereas men with 10 years or less of sexual experience may be forming sexual networks with peers who are newly encountering the epidemic and may have HIV-1 infection of shorter duration and higher infectivity. In addition, men with

10 years or less of sexual experience tended to be more often under 25 years of age (65 versus 5%, $P < 0.0005$) and may have been more likely to form sexual partnerships with younger women. In Kenya, the highest seroprevalence among women occurs in the 15–25 year age group [22]. Given that approximately 60% of Kenya's population is 25 years or under (KHDS) and that half of the men within this cohort had commenced sexual relationships by the age of 15 years, these data would suggest a re-focussing of the AIDS message to people in their early teens [20].

Our study found that uncircumcised status was associated with a 2.3-fold increased risk of HIV-1 seroconversion in multivariate analysis. Moses *et al.* [23], in a review of epidemiological studies that had evaluated the relationship between male circumcision and HIV-1 seroconversion, found that most showed a protective effect of circumcision. Many of the studies involved STD clinic attendees and, as such, may not have been reflective of the general population. In addition, most of the studies were cross-sectional in design. A strength of our study was its prospective nature, which permitted careful longitudinal assessment of sexual behavior and STDs, which may both confound the relationship between circumcision and HIV-1 acquisition. We found a protective effect of circumcision after adjusting for reported sexual behavior and other risk factors. A similar finding of increased risk of HIV-1 seroconversion among uncircumcised men was found by Cameron *et al.* [9], in a prospective study of seroconversion after a single high-risk exposure, conducted in a Nairobi STD clinic.

Because we had hypothesized that we might observe an association between circumcision status and HIV-1 risk, we collected data about religion because of its influence on circumcision practices. The association between non-Christian, non-Muslim religion and HIV-1 incidence was unexpected and we are unsure how to interpret the result. Men in this group were almost identical to Christian/Muslim men with regard to high-risk sexual behavior (e.g. unprotected extra-marital sex), so sexual exposure *per se* does not appear to explain the association. The number of men in this category was small (only 6%) and the confidence intervals around the estimate of risk were large, so we would caution against over-interpreting our finding.

Three limitations of our study were loss to follow-up over time, irregular follow-up leading to our inability to pinpoint the time of seroconversion in some cases, and the relatively small number of seroconverters, resulting in limited power to detect associations. Three-quarters of men returned for some follow-up and two-thirds of these were followed for at least 1 year. Although no differences between men who did and did not return after their enrollment visit were

identified with the exception of occupational group, it is possible that the incomplete retention of participants may have introduced bias. Because the occupational group at highest risk (drivers and drivers' assistants) was least likely to return for follow-up, our HIV-1 seroincidence estimate is probably conservative for trucking company employees as a whole. In future studies of trucking company workers, strategies to enhance follow-up could include improved access to the research clinic through the availability of a daily clinic in each company and satellite clinics at truck stops along major highways.

Conclusion

This study found that trucking company employees are an occupational group with high HIV-1 and STD incidence who are likely to contribute to the geographical dissemination of disease because of their mobility and sexual behavior. Correlates of HIV-1 seroconversion identified in this group of men included unprotected high-risk sexual encounters and uncircumcised status, as well as occupational group and religion. Because of their high HIV-1 seroincidence, trucking company employees constitute an appropriate group for HIV-1 prevention trials and behavioral interventions.

Acknowledgements

We thank the nurses, counsellors, and laboratory technicians who participated in this study (Bhavna Chohan, Anderson Kahindi, Francis Kashonga, Kalu Kazungu, Dorothy Landi, Gladwell Maina, Julius Matandi, Esther Mutunga, Khamis Mwinyikai, Cesar Ngao, Peter Njogu, Rose Ogolia, Beatrice Ouma), the management of the trucking companies that allowed us to conduct research in their sites, and the men of the cohort for their cooperation. J. Rakwar was a scholar in the International AIDS Research and Training Program supported by the Fogarty International Center, National Institutes of Health (D43-TW00007).

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